Decision Rationale

Total Maximum Daily Load for Fecal Coliform for Little Creek

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDL for fecal coliform for Little Creek. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The 8.64 square-mile Little Creek watershed is situated on the Virginia/Tennessee border and located in Washington County, VA. The TMDL addresses a 5.52 mile stream segment, beginning in the headwaters and terminating at the Tennessee state line. Forested (41%) and agricultural (30%) lands make up roughly 71% of the watershed.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 5.52 miles of Little Creek as being impaired by elevated levels of fecal coliform on Virginia's 1998 Section 303(d) list. Little Creek was listed for violations of Virginia's fecal coliform bacteria water quality standard. Almost three-quarters of the 189 water quality samples taken from

1971 through 2002 at VADEQ monitoring station 6CLTL000.26 failed to attain the standard. The stream was listed after Tennessee Department of Environmental Conservation's (TDEC) study on Beaver Creek (the stream which Little Creek flows into south of the Virginia state line). Eight of the ten samples taken from Little Creek over a thirty-day period failed to attain the instantaneous water quality standard for fecal coliform. Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA has been encouraging the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation has been drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth plans on adopting the e-coli and enterococci standards in late 2002.

As Virginia designates all of its waters for primary contact, all waters must meet the current fecal coliform standard for primary contact. Virginia's standard applies to all streams designated as primary contact for all flows. Through the development of this and other similar TMDLs, it was discovered that natural conditions (wildlife contributions to the streams) could cause or contribute to violations of the fecal coliform standard. Bacterial source tracking (BST) sampling data collected on Little Creek indicated that fecal coliform from wildlife alone can represent up to 42% of the instream fecal coliform concentration. Thus, many of Virginia's TMDLs, including the TMDL for Little Creek, have called for some reduction in the amount of wildlife contributions to the affected streams. EPA believes that a significant reduction in wildlife is not practical and will not be necessary due to the implementation plan discussed below.

A phased implementation plan will be developed for all streams in which the TMDL calls for reductions in wildlife. In the first phase of the implementation, the Commonwealth will begin implementing the reductions (other than wildlife) called for in the TMDL. In Phase 2, which can occur concurrently to Phase 1, the Commonwealth will consider addressing its standards to accommodate this natural loading condition. The Commonwealth has indicated that during Phase 2, it will evaluate the following items in relation to the standard. The Commonwealth may develop a Use Attainability Analysis (UAA) for streams with wildlife reductions which are not used for frequent bathing. Depending upon the result of the UAA, it is possible that these streams could be designated for secondary contact. The Commonwealth will also investigate incorporating a natural background condition for the bacteriological indicator.

After the completion of Phase 1 of the implementation plan, the Commonwealth will monitor the stream to determine if the wildlife reductions are actually necessary, as the violation level associated with the wildlife loading may be smaller than the percent error of the model or the MOS. In Phase 3, the Commonwealth will investigate the sampling data to determine if further load reductions are needed in order for these waters to attain standards. If the load reductions and/or the new application of standards allow the stream to attain standards, then no additional work is warranted. However, if standards are still not being attained after the implementation of Phases 1 and 2, further work and reductions will be warranted.

Little Creek identified as watershed VAS-O07R, was given a high priority for TMDL development. Section 303(d) of the CWA and its implementing regulations require a TMDL to be developed for those waterbodies identified as impaired by the state where technology-based and other controls do not provide for the attainment of water quality standards. The TMDL submitted by Virginia is designed to determine the acceptable load of fecal coliform which can be delivered to Little Creek, as demonstrated by the Hydrologic Simulation Program Fortran (HSPF)[1], in order to ensure that the water quality standard is attained and maintained. HSPF is considered an appropriate model to analyze this watershed because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to all of the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[2] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. These wastes do not need a transport mechanism to allow them to reach the stream. The allocation plan calls for the reduction in fecal coliform wastes delivered by cattle in-stream, wildlife in-stream, and failing septic systems.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL	WLA (cfu/yr)	LA (cfu/yr)	MOS (cfu/yr)
Total	Fecal Coliform	2.79E+14	8.29E+09	2.63E+14	1.58E+13

1 Virginia includes an explicit MOS by identifying the TMDL target as achieving the total fecal coliform water quality concentration of 190 cfu/100ml as opposed to the WQS of 200 cfu/ml. This can be viewed explicitly as a 5% MOS.

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[1]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

[2]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

EPA believes it is important to recognize the conceptual difference among the waste load allocation (WLA) values, load allocation (LA) values for sources modeled as direct deposition to stream segments, and LA values for flux sources of fecal coliform to land use categories. The WLA values and LA values for direct sources represent the amount of fecal coliform which is actually deposited into the stream segments. The HSPF model, which considers landscape processes which affect fecal coliform runoff from land uses, determines the amount of fecal coliform which reaches the stream segments. The LA in Table 1 is the amount of colony forming units (cfu) reaching the edge of stream from wet weather driven nonpoint sources annually.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a fecal coliform TMDL for Little Creek. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality standards and designated uses on Little Creek. The water quality criterion for fecal coliform is a geometric mean 200 cfu/100mL or an instantaneous standard of no more than 1,000 cfu/100ml. Two or more samples over a 30 day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a thirty-day period, most of the samples are measured against the instantaneous standard. This stream was listed due to violations associated with the geometric mean standard, although, previous data indicated that the stream was not attaining the instantaneous standard. There were several monitoring locations along Little Creek which have been used by VADEQ and TDEC to measure the stream's compliance with the standard. Violation rates between 73% and 100% were documented at stations with more than 30 samples.

The HSPF model is being used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from point and other direct deposit sources necessary to support the fecal coliform water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of fecal coliform to Little Creek will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Data used in the model was obtained on a wide array of items, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, land uses, weather, stream geometry, etc.. The model combined all the data to determine the hydrology and water quality of the stream.

Calibration is the process of comparing modeled data to observed data and making appropriate adjustments to model parameters to minimize the error between observed and simulated events.[3] A "paired watershed" approach was used for the hydrology calibration for Little Creek. A "paired watershed" or "equivalent watershed" approach was used because there was insufficient hydrology data on Little Creek. In a "paired watershed" approach, the modelers model the hydrology of a stream with a long term hydrologic record (Beaver Creek) that would have a response similar to the watershed being studied (Little Creek).

The Beaver Creek watershed had very similar land uses to Little Creek with agriculture and forests making up 89% of the watershed. United States Geological Survey (USGS) had a continuous gage monitoring flow on Beaver Creek from 1957 through 2000. The calibration was run from September 1993 through September 1998. Weather data for the model was obtained from the Bristol WSO Airport in Tennessee. Several parameters including the evapotranspiration rate, recession rates to groundwater and interflow, storage capacity within the subsurface and surface zones, slope, and forest cover were evaluated and or adjusted to insure that the calibration closely represented the observed data. The statistical flow checks indicated that the simulation matched the observed flow data on Beaver Creek within the accepted bounds.

A validation run was conducted to see how well the model simulated observed data from Beaver Creek over a different time period. This was conducted to insure that the model could simulate different conditions on Beaver Creek. The validation used data from October 1998 through September 2000. The simulated data from the validation compared favorably to the observed conditions as well.

The model was then transferred to Little Creek for water quality calibration. The water quality calibration was from January 1990 to December 1991. The model was then validated against observed data form August 2001 through February 2002. These periods were chosen because they were more extensively sampled then other time periods. During the water quality calibration and validation hourly simulated data was evaluated against the sporadic grab samples. This makes it difficult to determine the accuracy of the model.

EPA believes that using HSPF to model and allocate fecal coliform will ensure that the designated uses and water quality standards will be attained and maintained for Little Creek.

2) The TMDL includes a total allowable load as well as individual waste load allocations and

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[3]Maptech, 2002. Fecal Coliform TMDL Development for Catoctin Creek Impairments, Virginia. April 23, 2002.

load allocations.

<u>Total Allowable Loads</u>

Virginia indicates that the total allowable loading of fecal coliform is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments), directly deposited nonpoint sources of fecal coliform (cattle in-stream and wildlife in-stream), and point sources. Activities such as the application of manure and the direct deposition of wastes from grazing animals are considered fluxes to the land use categories. The actual value for the total fecal load can be found in Table 1 of this document. The total allowable load is calculated on an annual basis due to the nature of HSPF model.

<u>Waste Load Allocations</u>

Virginia has stated that there are three small point sources discharging to Little Creek. The facilities are listed in Table 2. These facilities are allowed to discharge 1,000 gallons of effluent per day with a fecal coliform concentration of 200 cfu/100 mL. Their WLAs were determined by multiplying the facility's allowable concentration (200 cfu/100 mL) by their permitted flow by the number of days in a year (365).

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2 - Waste Load Allocations for Little Creek

Facility Name	Permit Number	Existing Load	Allocated Load
Harrell Duplex I STP	VAG400007	2.76E+09	2.76E+09
Harrell Duplex II STP	VAG400006	2.76E+09	2.76E+09
Siloh Free Will Baptist Church	VAG400230	2.76E+09	2.76E+09
Total	N/A	8.29E+9	8.29E+09

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the Little Creek watershed. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint loadings, and receiving water quality for conventional pollutants and toxicants[4]. HSPF uses precipitation data for continuous and storm event simulation to determine total fecal loading to Little Creek from the various land uses within the watershed. The total land loading of fecal coliform is the result of the application of manure and direct deposition from cattle, other livestock and wildlife (geese, deer, etc.), the deposition of fecal coliform from failed septic systems, and fecal coliform production from pets.

In addition, VADEQ recognizes the significance of fecal coliform from directly deposited sources such as cattle in-stream and wildlife in-stream. These sources are not dependent on a transport mechanism to reach a surface waterbody, and therefore, can impact water quality during low and high flow events. Please note that all of the values in Table 3 other than the direct deposit nonpoint sources (cattle in-stream and wildlife in-stream) are given in terms of colony forming units to the land surface. The amount of waste from the wet weather nonpoint sources reaching the stream is significantly lower than what appears in Table 3.

Table 3 - LA for the Land Application of Fecal Coliform

Land Use/Source	Existing Load	Allocated Load	Percent Reduction
Forest	1.59E+11	1.59E+11	0%
Low Density Residential	4.36E+13	4.36E+13	0%
High Density Residential	9.58E+12	9.58E+12	0%
Pasture/Hay	1.62E+14	1.62E+14	0%
Row Crops	4.72E+13	4.72E+13	0%
Commercial, Industrial, Transportation	1.94E+11	1.94E+11	0%
Farmstead	7.27E+11	7.27E+11	0%

[4] Supra, footnote 2.

Septic Load	3.91E+09	0	100%
Cattle In-stream	2.05E+13	0	100%
Wildlife In-stream	1.31E+09	3.93E+08	70%

3) The TMDL considers the impacts of background pollution.

A background concentration was set by determining the wildlife loading to each land segment.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Little Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[5]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios.

The sources of bacteria for these stream segments were a mixture of dry and wet weather driven sources. Therefore, the critical condition for Little Creek was represented as a typical hydrologic year. Since the stream was modeled to attain the geometric mean standard and base and low flow events occurred far more often then wet weather events, it was essential that the standard be maintained during these periods. This is why the reductions are focused on those sources that impact the stream during base-flow conditions.

5) The TMDLs consider seasonal environmental variations.

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[5]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations. The model also accounted for the seasonal variation in loading. Fecal coliform loads changed for many of the sources depending on the time of the year. For example, cattle spent more time in the stream in the summer and animals were confined for longer periods of time in the winter.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The margin of safety (MOS) may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL.

Virginia includes an explicit margin of safety by establishing the TMDL target water quality concentration for fecal coliform at 190 cfu/ 100mL, which is more stringent than Virginia's water quality standard of 200 cfu/100 mL. This would be considered an explicit 5% margin of safety.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program. Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards. The Commonwealth intends to implement this TMDL through BMPs. The implementation of these practices will occur in stages. This is will allow the Commonwealth to monitor the benefits of the BMPs and determine which practices have the greatest impacts on water quality. It will also provide a mechanism for developing public support and checking the accuracy of the model. By staging the implementation of BMPs the Commonwealth will be able to verify the accuracy of the modeling assumptions.

The TMDL in its current form is designed to meet the applicable water quality standards. However, due to the wildlife issue that was previously mentioned, the Commonwealth believes that it may be appropriate to modify its current standards to address the problems associated with wildlife loadings.

8) The TMDLs have been subject to public participation.

Three public meetings were held to discuss TMDL development on Little Creek. All of the public meetings were public noticed in the *Virginia Register* and opened to at least a thirty-day comment period. The first meeting was held on December 06, 2001 in Bristol, VA. Seventeen people attended this initial meeting on the TMDL. Twenty-two people attended the second meeting which was held in Bristol, VA on March 07, 2002. The third and final public meeting was held in Bristol, VA on March 22, 2002.